

SOLAR OBSERVATIONS

[Meteorological Research Division, EDGAR W. WOOLARD in charge]

SOLAR RADIATION OBSERVATIONS, MAY 1939

By IRVING F. HAND

Measurements of solar radiant energy received at the surface of the earth are made at eight stations maintained by the Weather Bureau, and at nine cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at three Weather Bureau stations (Washington, D. C., Madison, Wis., Lincoln, Nebr.) and at the Blue Hill Observatory of Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau stations at Washington and Madison.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data, obtained up to the end of 1936, will be found in the MONTHLY WEATHER REVIEW, December 1937, pages 415 to 441; further descriptions of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and their departures from normal (means based on less than 3 values are in parentheses). At Madison and Lincoln the observations are made with the Marvin pyrheliometer; at Washington and Blue Hill they are obtained with a recording thermopile, checked by observations with a Marvin pyrheliometer at Washington and with a Smithsonian silver disk pyrheliometer at Blue Hill. The table also gives vapor pressures at 8 a. m. (75th meridian time) and at noon (local mean solar time).

During May normal incidence intensities averaged below normal at Washington, Madison, and Blue Hill and slightly above normal at Lincoln.

Total solar and sky radiation averaged above the May

TABLE 1.—Solar radiation intensities during May 1939—Continued

MADISON, WIS.

Date	Sun's zenith distance										Local mean solar time	
	8a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°		Noon
	75th mer. time	Air mass										
		A. M.					P. M.					
e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e		
May 1.....	mm. 4.57	cal.	cal.	cal.	cal. 0.89	cal. 1.00	cal. 1.48	.....	.....	.....	mm. 4.95
May 2.....	4.57	.....	0.84	1.07	1.25	1.48	.....	.....	.....	.....	4.78
May 5.....	8.48	.....	.....	.72	0.87	1.31	.....	.....	.....	.....	9.47
May 6.....	7.04	.....	.....	.77	1.06	.....	.....	.....	.....	.....	6.76
May 9.....	6.70	.....	.....	.81	1.12	1.39	.....	.....	.....	.....	4.57
May 10.....	5.79	.....	.....	.....	.....	1.09	.....	.....	.....	.....	4.37
May 11.....	4.75	.....	.....	1.00	1.24	.....	.....	.....	.....	.....	4.57
May 12.....	3.99	.....	.64	.80	.....	.....	.....	.....	.....	.....	5.36
May 13.....	4.57	.....	.61	.78	1.12	1.32	.....	.....	.....	.....	4.57
May 16.....	9.83	.....	.....	.....	.....	1.38	.....	.....	.....	.....	8.18
May 19.....	11.38	.....	.....	.....	.....	1.30	.....	.....	.....	.....	11.81
May 24.....	10.72	0.47	.57	.79	1.00	1.26	.....	.....	.....	.....	11.38
May 25.....	11.38	.36	.43	.64	.83	.....	.....	.....	.....	.....	14.10
May 31.....	15.65	.....	.....	.96	1.15	.....	.....	.....	.....	.....	16.20
Means.....	.....	.42	.62	.84	1.06	1.33	.....	.....	.....	.....	.....
Departures.....	.....	-.30	-.20	-.15	-.06	-.05	.....	.....	.....	.....	.....

LINCOLN, NEBR.

May 1.....	6.27	0.68	0.77	0.90	1.17	.....	1.11	0.88	0.71	0.58	7.04
May 4.....	9.14	.....	.....	.....	.....	.....	1.01	.79	.65	.51	11.81
May 5.....	10.21	.....	.69	.84	1.07	.....	.....	.....	.....	.....	9.47
May 6.....	8.18	.....	.....	.69	.....	.....	.....	.....	.....	.....	11.81
May 9.....	4.95	.90	1.03	1.17	1.34	1.52	1.25	1.04	.87	.....	6.27
May 13.....	4.95	.....	.....	.....	1.22	.....	.....	.....	.....	.....	6.02
May 15.....	4.95	.....	.98	1.13	1.31	.....	1.22	1.04	.89	.....	5.56
May 16.....	5.79	.....	.84	.97	1.16	1.42	.....	.....	.....	.....	8.81
May 19.....	10.21	.....	.85	.95	1.16	.....	.....	.....	.....	.....	13.13
May 23.....	14.60	.....	.....	.....	.....	.....	1.03	.80	.64	.....	17.37
May 25.....	15.79	.....	.....	.....	1.06	.....	.....	.....	.....	.....	16.20
May 29.....	10.59	.....	.93	1.08	1.25	1.47	.....	1.02	.85	.....	9.83
May 31.....	15.65	.....	.....	.....	1.13	1.40	.....	.....	.....	.....	9.47
Means.....	.....	(.79)	.87	.97	1.19	1.47	1.12	.93	.77	(.54)	.....
Departures.....	.....	+.12	+.08	+.05	+.08	+.09	+.01	+.02	-.02	-.13	.....

BLUE HILL, MASS.

May 1.....	4.2	.....	.....	.....	1.13	.....	.....	.....	.....	.....	4.0
May 5.....	6.5	.....	.....	.....	.....	1.18	.....	.....	.....	.....	6.8
May 6.....	6.1	.....	.....	.....	.....	1.05	0.80	0.50	.....	.....	7.6
May 7.....	9.6	.....	.....	.....	.80	.....	.....	.....	0.46	0.35	6.8
May 10.....	8.6	.....	.....	.....	.....	1.42	.....	.87	.73	.61	6.3
May 12.....	4.8	.....	.....	.....	1.23	1.40	1.18	1.03	.85	.74	3.8
May 14.....	4.6	.....	.....	.....	1.10	1.42	1.15	.90	.80	.68	4.8
May 15.....	3.6	.....	.....	.....	.....	1.38	1.22	1.08	.95	.86	4.0
May 16.....	5.0	.....	.....	.....	.....	1.46	.....	.....	.....	.....	4.6
May 18.....	6.1	.....	.....	.....	.....	.....	1.18	.95	.....	.....	2.0
May 20.....	7.9	.....	.....	.....	.....	1.11	.80	.....	.....	.....	9.6
May 24.....	7.4	.....	.....	.....	.....	1.41	.....	.....	.....	.....	7.1
May 26.....	7.6	.....	.....	.....	.....	.....	.99	.85	.71	.....	5.8
May 30.....	10.7	.....	.....	.....	.....	1.35	.....	.....	.71	.....	9.9
May 31.....	12.3	.....	.....	.....	.....	1.24	.....	.....	.50	.....	9.6
Means.....	.....	.....	.....	.....	1.06	1.31	1.05	.88	.71	.65	.....
Departures.....	.....	.....	.....	.....	-.07	-.06	-.04	-.03	-.06	-.05	.....

*Extrapolated.

normals at all stations with the exception of Miami, New Orleans, Riverside, Friday Harbor, Ithaca, and Newport. It is interesting to note that all the inland stations with the exception of Ithaca had large plus departures, while every coastal station showed a deficiency.

TABLE 1.—Solar radiation intensities during May 1939
[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance										Local mean solar time	
	8a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°		Noon
	75th mer. time	Air mass										
		A. M.					P. M.					
e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e		
May 4.....	mm. 4.57	cal.	cal.	cal.	cal. 1.15	cal. 1.44	cal. 0.96	cal.	cal.	cal.	mm. 4.75	
May 5.....	7.04	.....	.....	0.62	0.80	.....	.....	.....	.....	.....	4.95
May 6.....	8.18	.....	.....	.....	.78	.....	.....	.....	.....	.....	8.18
May 10.....	8.81	.....	.....	.....	.....	1.38	.....	.....	.....	.....	7.29
May 12.....	4.95	.....	.....	.....	.....	1.40	.....	.....	.....	.....	4.37
May 15.....	6.27	.....	.....	.93	1.16	1.46	.....	.....	.....	.....	3.00
May 23.....	15.65	.....	.....	.68	.....	.....	.....	.....	.....	.....	11.10
May 24.....	11.38	0.34	0.42	.69	1.04	1.41	.....	.....	.....	.....	8.18
May 31.....	14.60	.....	.....	.97	1.07	.....	.....	.....	.....	.....	12.24
Means.....	.....	(.34)	(.42)	.80	.95	1.42	(.96)	.....	.....	.....	.....
Departures.....	.....	-.29	-.30	-.04	-.06	+.14	+.02	.....	.....	.....	.....

TABLE 2.—Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface

Week beginning—	Gram-calories per square centimeter																
	Wash- ington	Madison	Lin- coln	Chica- go	New York	Fresno	Fair- banks	Twin Falls	La Jolla	Miami	New Orleans	River- side	Blue Hill	San Juan	Friday Harbor	Ithaca	New- port
Apr. 30.....	cal. 525	cal. 637	cal. 572	cal. 573	cal. 446	cal. 601	cal. 383	cal. 569	cal. 583	cal. 451	cal. 482	cal. 545	cal. 442	cal. 672	cal. 504	cal. 474	cal. 457
May 7.....	*516	542	578	532	439	598	444	615	499	452	475	466	495	674	668	370	495
May 14.....	670	604	610	535	588	659	517	579	531	496	429	471	704	580	514	478	686
May 21.....	617	587	574	558	400	683	411	641	700	495	362	644	401	629	493	308	429
May 28.....	492	532	680	559	557	698	565	646	501	491	338	539	661	615	556	275	699
Departures of daily totals from normals																	
Apr. 30.....	+55	+190	+97	+177	+48	+60	-16	+51	+21	-59	+59	-6	-51	+55	-50	+92	-46
May 7.....	+61	+61	+123	+123	+44	-48	-6	+24	-61	-82	+70	-83	+4	+110	+108	-33	-25
May 14.....	+199	+124	+90	+106	+166	-9	+44	-27	+9	+2	+20	-39	+174	+77	-34	+25	+160
May 21.....	+112	+92	+19	+99	-45	+6	-38	-5	+195	-5	-52	+90	-127	+67	-68	-179	-116
May 28.....	-27	+34	+152	+85	+84	+10	+128	+49	-29	+23	-145	-12	+79	+33	0	-194	-38
Accumulated departures since Jan. 1																	
	+5, 915	+4, 669	+3, 899	+6, 888	+1, 575	-581	-595	+119	+2345	+896	+5, 019	-1, 841	-840	+7, 189	+1, 907	-6, 713	-1, 547

*5-day mean.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.) Superintendent, U. S. Naval Observatory. Data from measurements at the U. S. Naval Observatory from plates obtained at the observatories indicated. Difference in longitude is measured from the central meridian, positive toward the west. Latitude is positive toward the north. Areas are corrected for foreshortening and expressed in millionths of Sun's visible hemisphere. For each day, below longitude, latitude, area of spot or group, and spot count, are given respectively the assumed longitude of the center of the disk, assumed latitude of the center of the disk, total area of spots and groups, and total spot count]

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	East- ern stand- ard time	Mount Wilson group No.	Heliographic				Area of spot or group	Spot count	Plate qual- ity	Observatory
			Dif- fer- ence in longi- tude	Longi- tude	Latitude	Dis- tance from cen- ter of disk				
1939	h m		°	°	°	°				
May 1...	11 12	6424	-88	78	+12	88	194	2	VG	U. S. Naval.
		6423	-80	86	-11	80	24	1		
		6422	-53	113	+22	59	24	2		
		6418	-49	117	+12	51	727	10		
		6414	-22	144	-23	29	97	6		
		6417	-19	147	-11	21	48	1		
		6413	-12	154	+22	27	24	3		
		6414	-11	155	-21	20	61	1		
		6417	-11	155	-10	13	85	1		
		6413	-5	161	+21	25	121	7		
		6415	-5	161	+12	16	145	16		
		6421	+3	169	-16	13	48	4		
		6410	+33	199	-11	34	145	2		
		6410	+39	205	-10	39	20	6		
		6412	+59	225	-15	60	174	6		
		6420	+90	225	+18	62	61	4		
		6407	+68	234	+30	73	824	16		
		6406	+72	238	-17	72	455	1		
		6408	+77	243	+6	78	97	1		
		6405	+80	246	+25	82	97	1		
May 2...	8 59		(166)	(-4)			3, 501	91	VG	Mt. Wilson.
		6424	-76	78	+11	77	582	12		
		6423	-69	85	-9	69	73	3		
		6422	-38	116	+22	46	291	16		
		6418	-37	117	+11	40	727	45		
		6414	-12	142	-23	23	145	3		
		6417	-7	147	-11	10	12	3		
		6414	-3	151	-21	18	145	14		
		6417	+1	155	+11	7	97	6		
		6415	+7	161	-11	16	36	6		
		6413	+8	162	+19	24	121	15		
		6421	+16	170	-18	22	36	28		
		6410	+37	191	-11	45	9	8		
		6410	+45	199	-11	45	97	4		
		6412	+68	222	-15	68	145	18		
		6420	+70	224	+16	72	97	11		
		6407	+82	236	+30	85	242	8		
		6406	+85	239	-17	85	194	2		
			(154)	(-4)			3, 046	202		

Date	East- ern stand- ard time	Mount Wilson group No.	Heliographic				Area of spot or group	Spot count	Plate qual- ity	Observatory
			Dif- fer- ence in longi- tude	Longi- tude	Latitude	Dis- tance from cen- ter of disk				
1939	h m		°	°	°	°				
May 3...	8 53	6424	-62	79	+11	64	582	18	VG	Mt. Wilson.
		6423	-54	87	-8	54	145	12		
		6422	-24	117	+22	34	339	55		
		6418	-23	118	+11	28	727	50		
		6414	+1	142	-23	20	73	18		
		6414	+10	151	-21	20	36	19		
		6417	+14	155	-11	16	73	10		
		6415	+20	161	+12	25	6	2		
		6413	+20	161	+19	30	85	7		
		6410	+59	200	-11	59	97	6		
		6420	+82	223	+15	83	36	3		
		6412	+83	224	-14	83	194	4		
May 4...	10 59		(141)	(-4)			2, 393	204	G	U. S. Naval.
		6426	-76	51	+8	77	48	10		
		6424	-47	80	+11	49	436	10		
		6423	-41	86	-9	41	61	4		
		6418	-13	114	+14	21	436	21		
		6422	-12	115	+22	28	485	36		
		6418	-9	118	+11	17	339	9		
		6414	+15	142	-23	24	36	5		
		6414	+28	155	-20	33	12	1		
		6417	+29	156	-11	30	61	1		
		6413	+38	165	+19	44	109	7		
		6425	+47	174	-7	47	24	3		
		6410	+74	201	-11	74	145	1		
May 5...	11 31		(127)	(-4)			2, 192	99	VG	Do.
		6426	-63	50	+9	65	48	2		
		6424	-35	78	+10	37	97	16		
		6424	-31	82	+11	34	388	1		
		6423	-26	87	-9	26	121	12		
		6418	+2	115	+14	17	533	66		
		6422	+2	115	+23	26	533	42		
		6418	+6	119	+11	16	436	12		
		6417	+42	155	-10	42	48	1		
		6413	+50	163	+19	54	73	6		
		6425	+61	174	-7	67	6	1		
		6410	+80	193	-15	80	48	4		
		6410	+83	196	-11	83	48	1		
May 6...	10 58		(113)	(-4)			2, 379	164	VG	Do.
		6426	-50	50	+9	51	24	2		
		6424	-22	78	+10	26	97	16		
		6424	-18	82	+12	23	291	5		
		6423	-13	87	-8	14	71	13		
		6422	+15	115	+23	30	533	38		
		6418	+15	115	+14	22	533	70		
		6418	+20	120	+11	25	388	10		
		6417	+56	156	-9	50	61	1		
		6413	+63	163	+19	57	73	4		
			(100)	(-4)			2, 071	159		